Exposure Assessment

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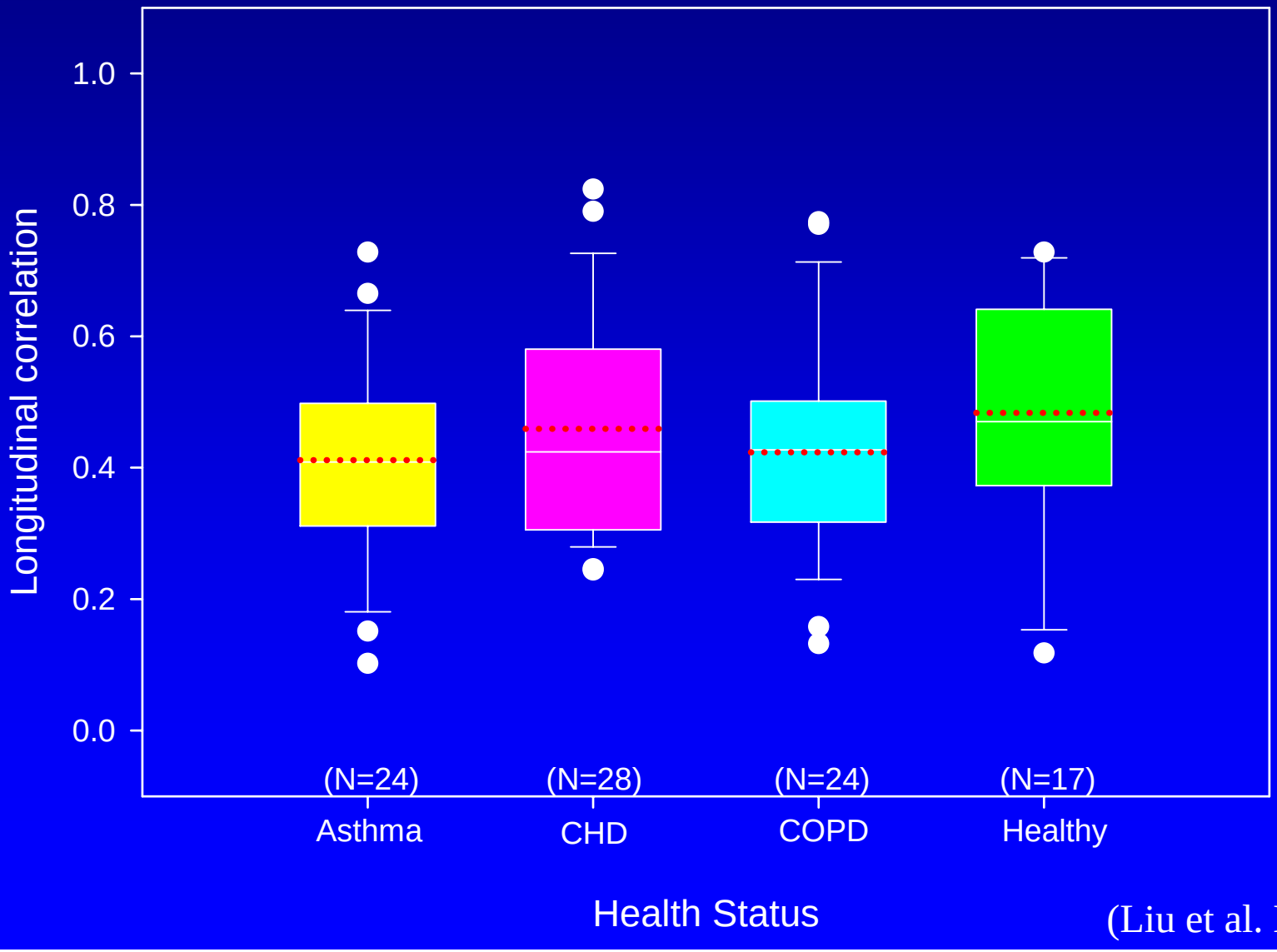
Top 4 arguments for not to believe in ambient measurements

- Low correlations between personal exposure and ambient measurements
- People spend the majority of time indoors.
- Total personal exposure usually exceeds the ambient and indoor concentrations
- Home outdoor concentrations depend on proximity to roads, elevation, etc. (Goswami et al., 2002; Hoek et al. 2002)

Exposure is correlated with ambient measurements within individual

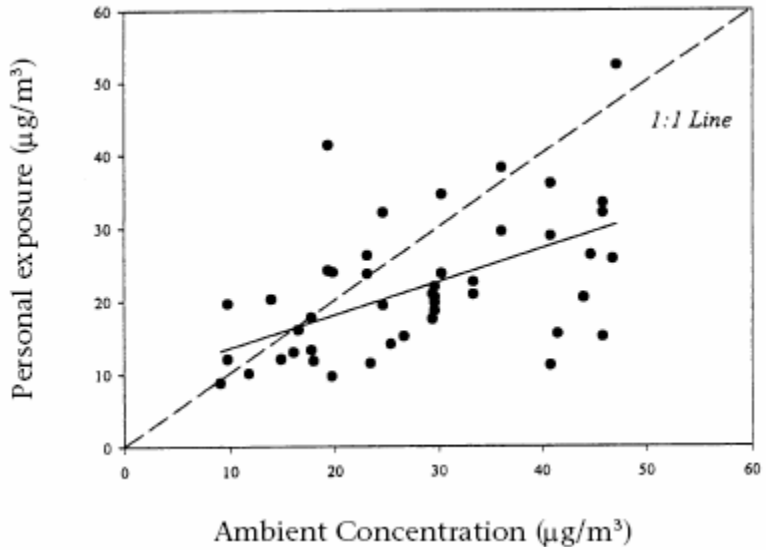


(Liu et al. EHP 2003)

But why does total exposure exceed ambient measurements?

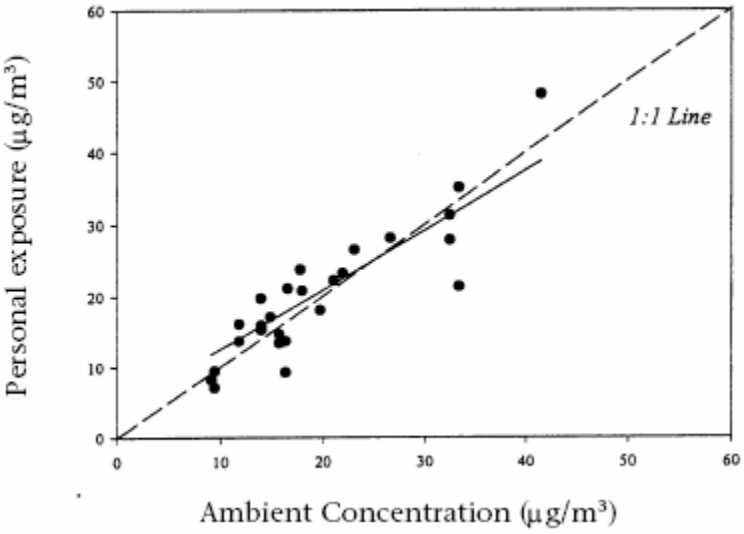
- Total exposure can be separated into 3 groups:
  - Ambient generated particles (EPA regulated)
  - Indoor generated particles
  - Personal generated particles
- Exposure to ambient generated particles
  - Is correlated with ambient measurements
  - Can be predicted
- Exposure to non-ambient generated particles
  - Results in total exposure exceeding ambient measurements
  - Masks the personal-ambient relationship

Good ventilation increases infiltration of ambient particles



Poorly ventilated homes

crude $R^2 = 0.25$;
slope = 0.46 (CI: 0.30-0.61); $p < 0.0001$;
N = 45



Well ventilated homes

crude $R^2 = 0.80$;
slope = 0.83 (CI: 0.60-1.06); $p < 0.0001$;
N = 26

(Sarnat et al. JAWMA 2000)

Exposure to ambient derived PM can be predicted, using ambient measurements

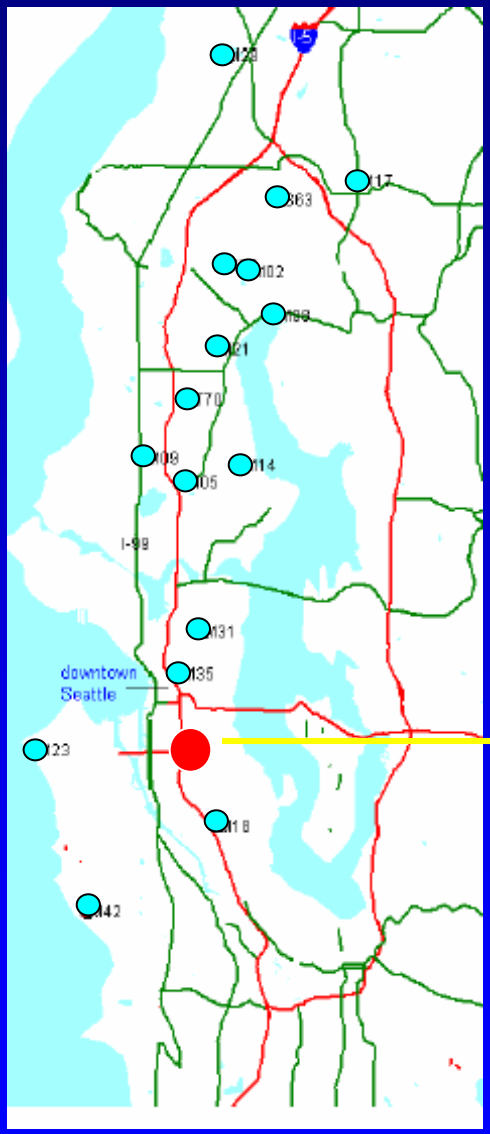
- Time spent outdoors
- Time spent indoors and infiltration efficiency of particles
  - Type of residence
    - Private home
    - Private apartment
    - Group retirement facility
  - Use of air cleaner
  - Average outdoor temperature
  - Average daily rainfall

(R^2=0.69, Allen et al. JAWMA 2004; Koenig et al. EHP 2004 submitted)

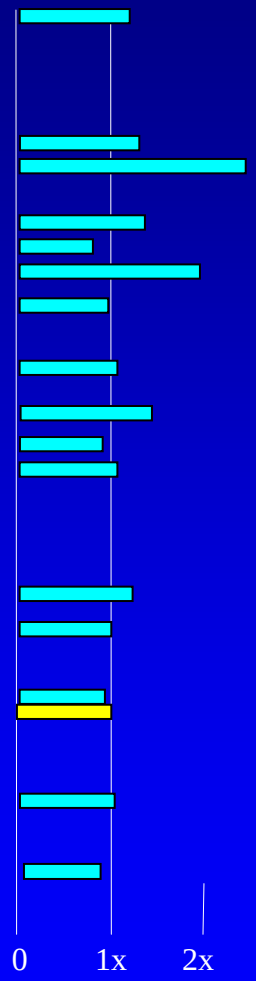
However, PM is not made equal everywhere.

- Total $PM_{2.5}$ is more or less spatially homogeneous
- Regional particles, such as sulfur, sulfate and nitrate, are spatially homogeneous.
- Local particles, such as vehicle exhaust and wood smoke, exhibit spatial variability
- Ultrafine particles show substantial variation near highways

Significant spatial variation in $PM_{2.5}$ in Seattle



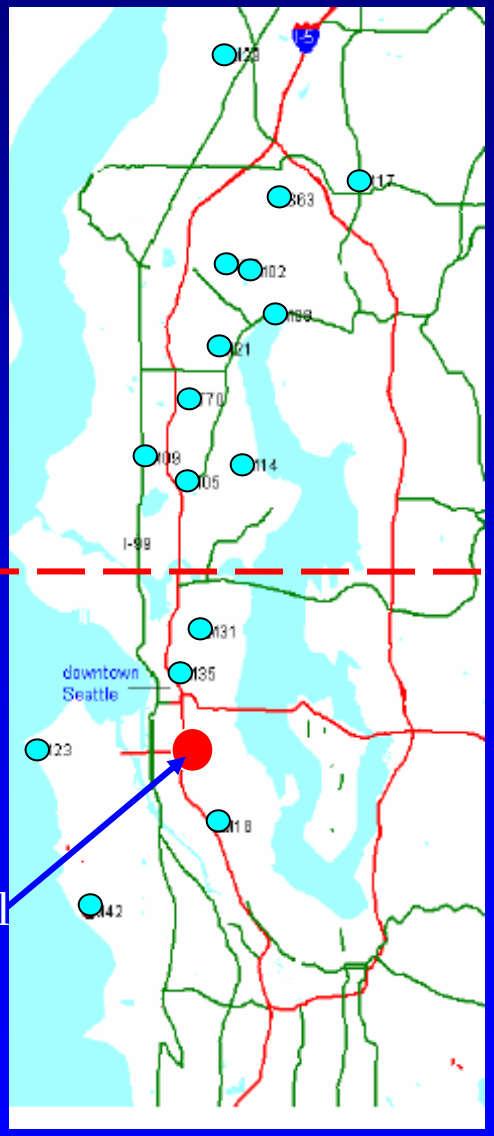
Beacon Hill



$$\frac{\text{Concentration outside home}}{\text{Concentration at Beacon Hill}}$$

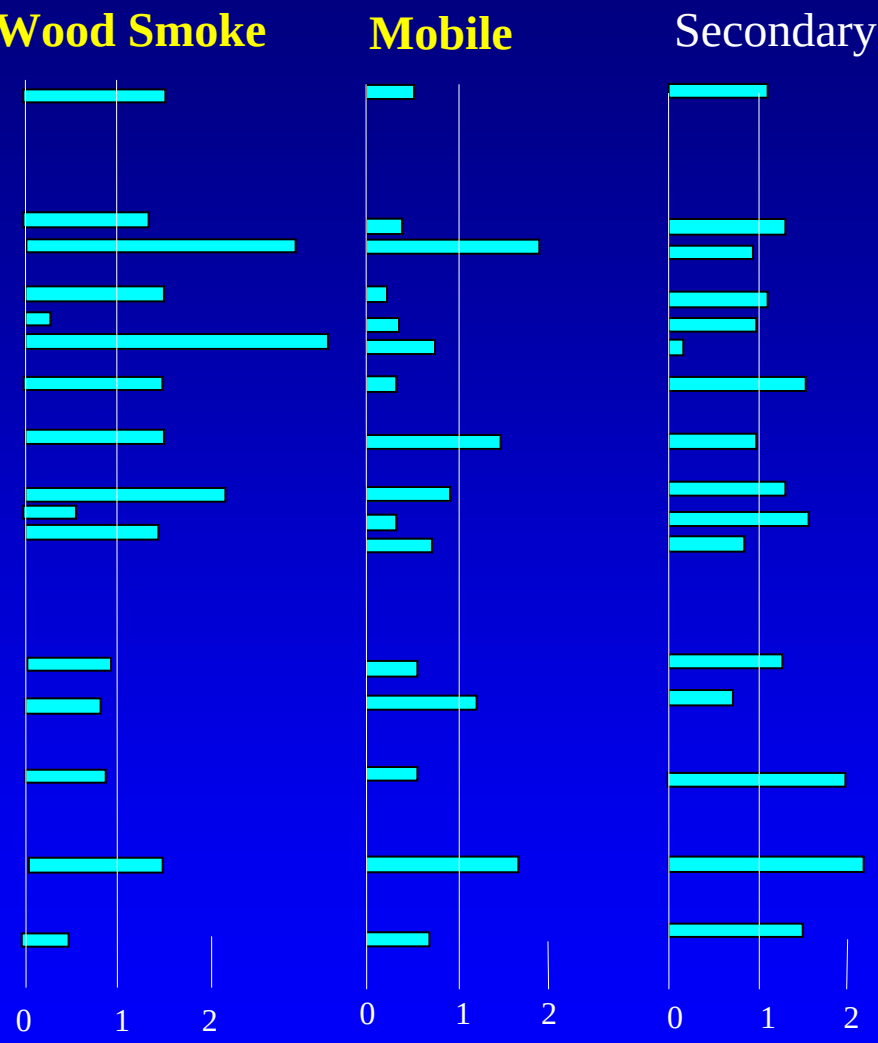
(Goswami et al. JAWMA 2002)

Substantial spatial variation in **local** sources



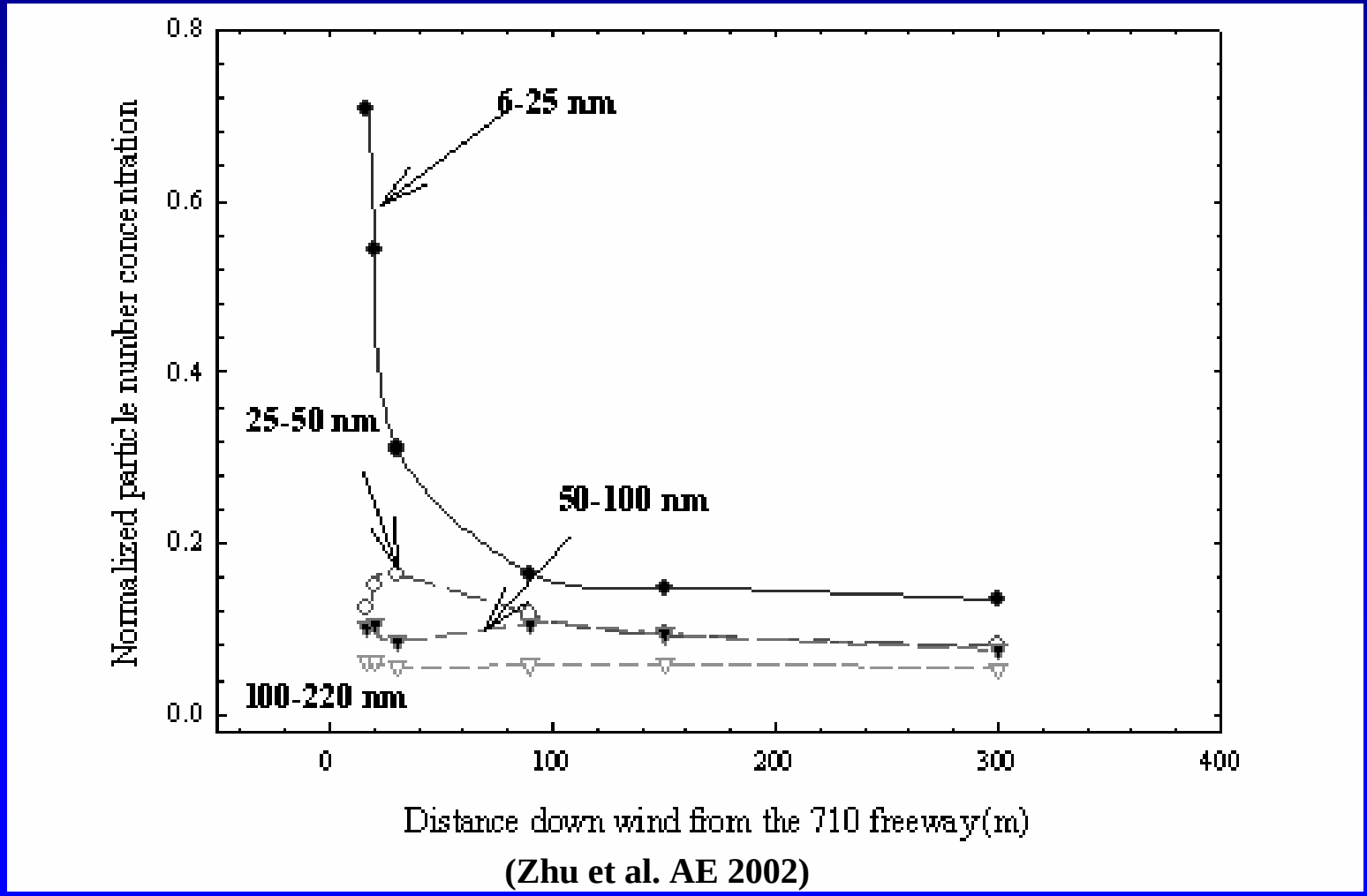
Beacon Hill

(Larson et al. JAWMA 2004)



Concentration outside home / Concentration at Beacon Hill

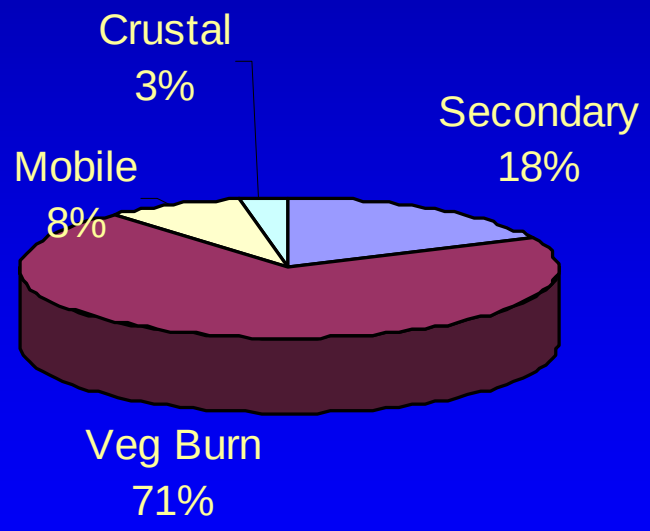
Exposure to ultrafine PM from traffic exhaust varies substantially near highways



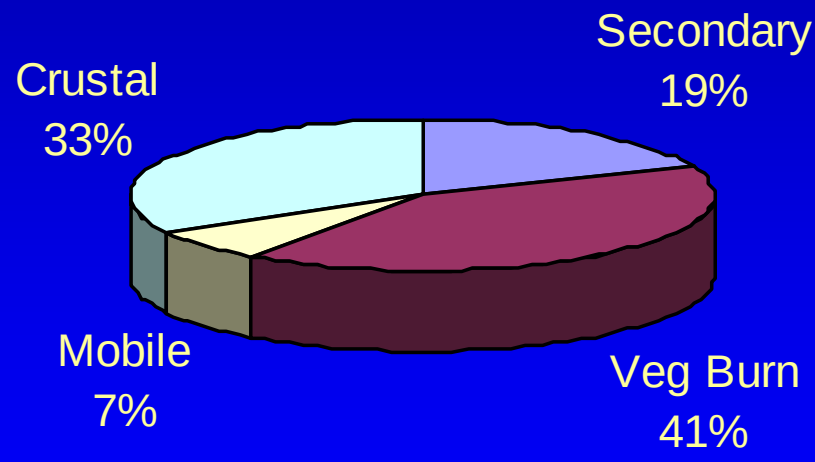
(Zhu et al. AE 2002)

Source contributions differ between ambient and personal air

Home outdoor



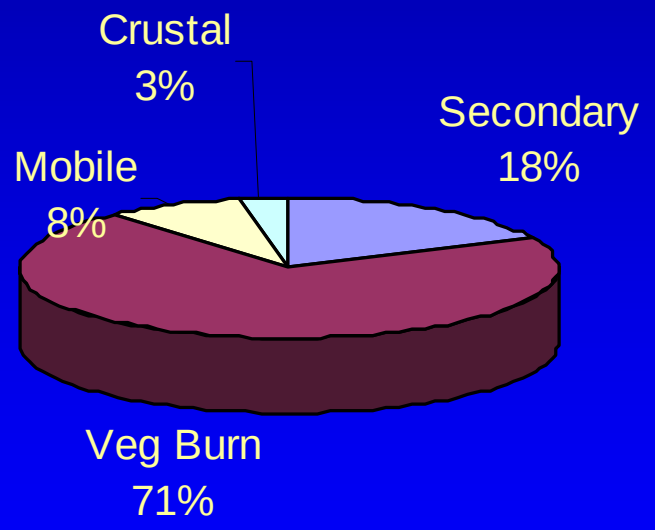
Personal



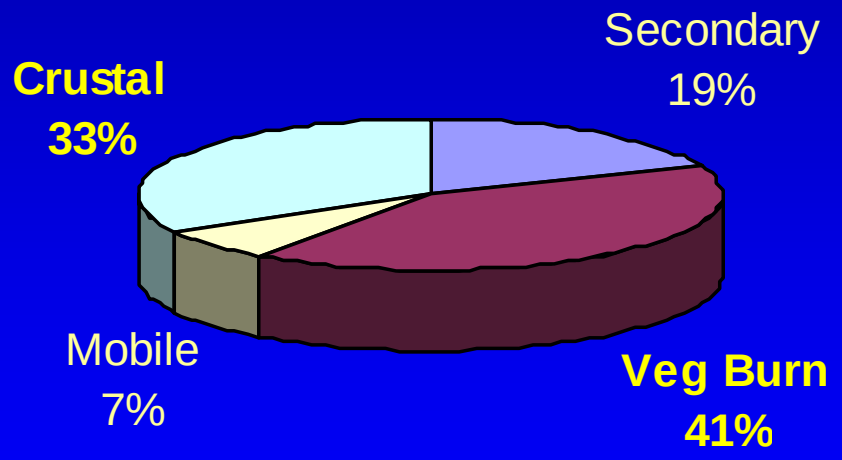
(N=61 from 20 residences/subjects. Larson et al. JAWMA 2004)

Source contributions differ between ambient and personal air

Home outdoor



Personal



While ambient PM can be used to predict personal exposure, it may not predict exposure to certain sources.

(N=61 from 20 residences/subjects. Larson et al. JAWMA 2004)

Conclusions

- It is appropriate to use ambient measurements as surrogates of exposure to $PM_{2.5}$ of outdoor origin.
- Exposure to ambient generated particles varies by individuals but can be predicted.
- Exposure to regional particles can be easily predicted using ambient measurements.
- However, exposure to combustion related particles differ from ambient measurements.

What's next?

- Predict PM exposures for individuals, at-risk groups, and the general population in specific cities, giving information on subject and home characteristics.
- Provide source specific exposure estimates to chronic and acute health effect studies
- Use biomarkers or remote sensing techniques for exposure assessment
- Calculate uncertainties in health effect estimates due to exposure measurement errors.